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APPARENT HIBERNATION BY THE ATLANTIC LOGGERHEAD TURTLE *CARETTA CARETTA* OFF CAPE CANAVERAL, FLORIDA

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ABSTRACT

During the winter of 1978 large numbers of torpid loggerhead turtles Caretta caretta *were taken by shrimp trawlers in the Port Canaveral Ship Channel, off the East Coast of Florida. During February and March the writers made experimental trawl drags in the same channel, and took 56 loggerheads in 123 minutes' drag time on the first trip and 100 in 128 minutes on the second trip. This represents by far the heaviest incidental trawler catch of turtles on record, and the aggregation sampled is the most concentrated ever reported for any species of sea turtle in a non-breeding habitat. The cause of the assemblage is unknown. Thermal data and other evidence strongly suggest that, on the first trip, most of the torpid turtles had been dragged out of the bottom and walls of the channel, and thus were hibernating. The implication that in temperate-zone sections of its range the loggerhead may sometimes hibernate, as some freshwater turtles do, is supported by widespread fishermen's opinion, and by the recent discovery of black turtles hibernating in the Gulf of California, at water temperatures almost identical to those recorded here for our February cruise.*

INTRODUCTION

The recent discovery of hibernation by the black turtle *Chelonia agassizi* in the Kino Bay area of the Gulf of California (Felger *et al.*, 1976) suggested that fishermen's reports of overwintering by young ridley and green turtles *Lepidochelys kempi* and *Chelonia mydas* in Florida had received inadequate attention (Carr & Caldwell,

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1956). In the present paper we present evidence of clumped overwintering by torpid loggerhead turtles *Caretta caretta* in the Port Canaveral Ship Channel leading into the Banana River at Cape Canaveral on the East Coast of Florida (28°24'N, 80°34'W: Fig. 1).

In mid-January 1978, Dr Carlyle Blakeney of the Charleston, South Carolina, office of the National Audubon Society told Carr that two Charleston shrimp boats had caught unprecedented numbers of loggerheads in trawls off Cape Canaveral, Florida. The region is known to be one in which the incidental take of sea turtles by shrimp trawlers is high; but the locality most often involved is off False Cape, 32 km north of the place where the Charleston shrimpers took their turtles. The trawlers

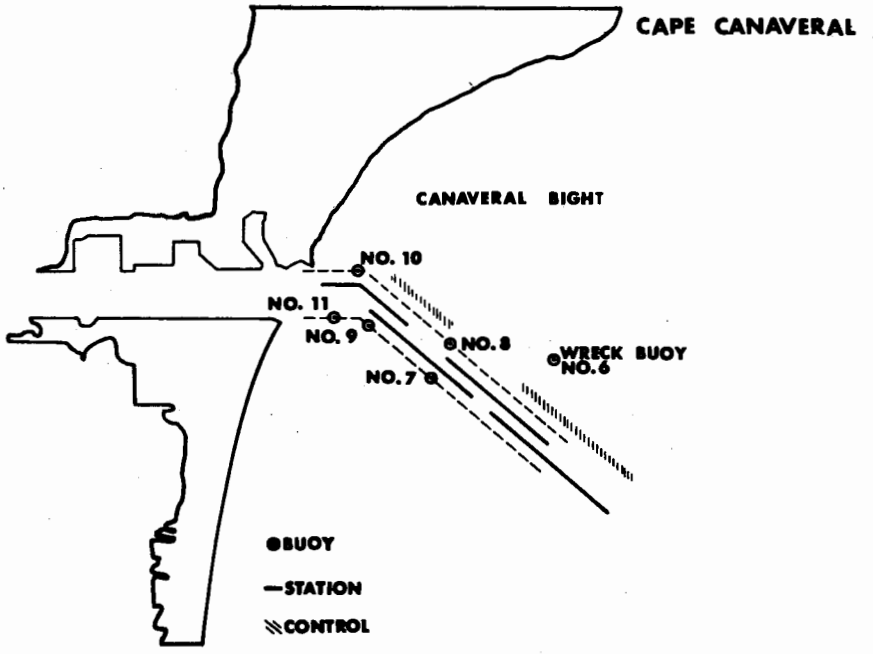

Fig. 1. Location of stations in the Port Canaveral Ship Channel where almost all of the turtles were captured (dark lines), and area outside channel where few or no turtles were captured (shaded lines). Channel depth range 14·5–15·5 m.

were searching for a concentration of shrimp when they entered the Canaveral channel. One boat caught 15 loggerheads in 20 minutes; the other took 66 in a one-hour drag. The captured turtles were said to have been immature, weighing between 18·1 kg and 63·5 kg. They were feeble and listless. Some were smeared with a substance that looked like tar and the shells of others were partly mud-covered and partly encrusted with invertebrates. The appearance and behaviour of the turtles led the shrimpers to conclude that they had been partially buried in the mud for a long time and had been dislodged by the trawls.

During the following February and March the authors made two visits to the ship channel on the R/V *Lady Weesa*, a trawler under contract to the National Marine Fisheries Service for gear testing. Prior to our first trip Captain Sidney Floyd had, on 12 February, made two 20-min test tows with an 18 m trawl, and one with a 6 m try-net, in the channel. He took 19 turtles in the first tow, 11 in the second, and 2 in the try-net.

On our first trip to the Cape (14–15 February), five tows with an 18 m trawl in the channel, totalling 123 min, yielded 56 turtles. In two additional 20-min tows, just outside the channel, only one turtle was caught, and this may have been taken as the net slipped back over the edge of the channel. On the second trip (15–17 March) six tows totalling 128 min were made in the channel, and 100 turtles were taken. Not all the turtles captured were landed on deck; some escaped at the surface as the net was brought on board. One 20-min drag outside the channel yielded none. Except for three sub-adult ridleys, all the turtles captured by us were loggerheads. Approximately 85 % were immature or sub-adult. Overall carapace lengths of 130 of these ranged between 57·5 cm and 98 cm (mean 69·09 cm, SD 9·11; var. 82·4).

Captain Floyd continued to fish in the area after our departure and provided us with the following additional capture data for 17–19 March 1978. Five tows made in the channel, totalling 98 min, yielded 83 loggerheads. In six tows outside the channel, totalling 104 min, only four turtles were captured. One turtle captured on 18 March had been tagged by us two days earlier.

Deep cloacal temperatures of the turtles were taken with a YSI telethermometer (Yellow Springs Instrument Thermistemp). Each turtle was measured and tagged. All turtles were released at sites a few hundred metres south of the channel.

While the cause of this extraordinary assemblage of loggerheads is not clear, thermal factors were probably involved. The turtles appeared to be too lethargic to have been actively feeding when they were caught. What seems most probable is that they had gone separately and independently into the ditch, not to socialise or to forage, but to take refuge from low water temperatures.

The meaning of hibernation in the case of ectotherms is not very clear, but a lowered metabolic state clearly must attend the underwater overwintering of other reptiles and amphibians. The discovery by Felger *et al.* (1976) that *Chelonia agassizi* spends the winter in bottom mud in the Gulf of California lent credence to the fishermen's belief, cited by Carr & Caldwell (1956), that some of the sub-adult ridleys and green turtles that show up along the west coast of mid-peninsular Florida in April, and disappear in November, pass the winter buried in the bottom. In both localities it is believed that not all the turtles overwinter, because some turn up clean and fat in the spring and appear to be recent immigrants.

In an effort to get visual confirmation that the Canaveral loggerheads were imbedded in the bottom, Ogren and McVea made a 20-min dive. However, visibility just off the bottom was less than a metre and was completely obscured by turbid water at the bottom, preventing a systematic underwater search for buried turtles.

Nevertheless, preponderant evidence from our first trip indicated that the captured turtles were torpid and that many of them had been imbedded in mud, some belly-down in the bottom, some stuck sideways or even head first into the side of the channel cut. Similar observations were made by our Charleston informant on 25 November 1977: listlessness, profuse but patchy fouling of the shell; and what seemed clear proof of interment in anaerobic mud: the numerous cases in which a part of the shell was covered with sulphide slime; or with dead barnacles on one side and live invertebrates on the other (Fig. 2).

Fig. 2. Loggerhead turtle trawled from Port Canaveral Ship Channel. The black sulphide slime suggests strongly that the turtle had been imbedded in bottom mud.

Whatever the physiological state of the turtles might have been, their burial in the bottom must have been voluntary, and not merely a result of torpor and passive silting. Although the bottom of the channel was softer than the sandy mud of the sea bottom, it still was much too hard for a turtle to sink passively into it. The surface was a firm, clay-like 'skin', with somewhat softer layers beneath. Outside the channel, the sea bottom was firm sandy clay, probably impossible for a turtle to penetrate. It seemed particularly obvious that the turtles stuck into the channel bottom and walls of the cut could only have got there by their own efforts, prior to becoming torpid.

Further evidence that the turtles were buried was provided by thermal data. The water temperature on the first trip was approximately 11 °C, and the temperatures of the turtles ranged consistently 2–3 °C higher (average 14 °C, range 13–15 °C). This suggested the possibility that loggerheads, like leatherbacks *Dermochelys coriacea* (Frair *et al.*, 1972) might thermoregulate. The torpid state of the animals that we caught made this seem unlikely, however; and when divers took down a probe and found that temperatures 25 cm deep in the mud were nearly identical with those of the turtles, the need to appeal to thermoregulation disappeared, and the case for hibernation was reinforced.

Data from the second trip provided additional evidence. By then, the water temperature had risen to 19 °C. The turtle temperatures were almost the same (average 19 °C, range 18–20 °C). This suggested that on this occasion the trawl had not dragged the turtles out of the mud, but instead had picked them up above the bottom. Their behaviour on deck supported that assumption. Many of them were active, inclined to bite, and less decrepit and dingy than those taken before. Our conclusions that on this date they were beginning to emerge from hibernation seemed strengthened by repeated sightings of turtles surfacing to blow with a cloud of mud spreading around them. Two of these still had stacks of mud on their backs; on the head of another there was a conch the size of a teacup that remained in place during two successive surfacings of the turtle.

Besides the patchy distribution of fouling, mud and sulphide slime, the condition of the turtles taken in the trawl had other puzzling aspects. The shells of many of them were fractured, and there was peeling of the laminae. Crescent-shaped and straight-line fractures of the bony carapace were recurrent, and some of these appeared to be of recent origin. There was also a curiously consistent fracture of the caudal end of the carapace, extending across the back edges of the costals, or involving only the inner edges of the scutes above the tail. The cause of these breaks was not clear; transient vessels or trawlers may have been involved.

Of the 150 or more turtles tagged or seen by us, and many others taken or described by informants, the most desperate condition was that of a group reported floating at the surface offshore. On 11 February a trawler captain, who had been fishing for rock shrimp 38 nautical miles (120 °C) out from the ship channel, radioed that there were numerous floating turtles there. He estimated their number as between 150 and 200, with 50–60 concentrated in one small area. He said they looked sick and made no attempt to escape by diving or swimming when the boat approached. Some were blind, many had lost their flippers, and there were areas of bare bone on their heads and shells. Dense growths of long filamentous algae were attached to the submerged shell and throat surfaces of many of them, indicating that the turtles had spent considerable time floating in the photic surface water. None of the turtles that we trawled out of the turbid water of the channel had algae growing on them.

Perhaps these derelicts had been dragged out of the bottom by trawlers after the temperature of the water had become too low to permit resumption of normal

activity, and afterwards they had drifted aimlessly, buoyed by intestinal gas, unable to feed, and without energy to evade shark bites. What kept them together in the relatively closely knit group in which they were found is not clear, but it must have been some sort of eddy, because overt aggregation was clearly beyond their capacity. There was little doubt that the plight of these turtles was terminal.

DISCUSSION

There would seem no reason why a marine turtle with a range that enters the temperate zone should not have evolved an ability to hibernate. Overwintering in the mud—singly or in group hibernacula—is well known for freshwater turtles. Carroll & Ehrenfeld (1978) found 17 torpid wood turtles *Clemmys insculpta* aggregated in a deep place in a woodland stream in New Jersey. In the northern United States, snapping turtles *Chelydra s. serpentina* pass the winter under the ice, sometimes in large groups (Lagler, 1943). Wood *et al.* (1975) said that northern diamondbacks *Malaclemmys t. terrapin* pass winters resting in the creek bottom under water, burying themselves in the mud of creek banks, or taking refuge beneath undercut banks. One of us (Carr, 1952) has caught southern diamondback terrapins *M. t. centrata* in winter by probing domed areas on mud bottoms of saltmarsh streams in Georgia.

One reason for the resistance of zoologists to the idea of hibernating by marine turtles may be that all turtles of a given population appear not to do so. The belief of the Seri Indians that part of the Baja California populations emigrate in the autumn, while part go into the mud, seems well documented. According to R. Marquez, Instituto Nacional de Pesca, Mexico (pers. comm.), the two contingents are even recognisable on the nesting beach of the population at Maruata Bay in Michoacan. Females that overwinter in Baja California have dark, encrusted shells, while the shells of those that leave this area in the autumn are clean, and yellowish in colour. The view of Florida fishermen that the Florida west coast ridleys and greens show similar duality in their seasonal ecology was recorded by Carr & Caldwell (1956).

There remains the question of how regular an occurrence overwintering is in marine turtles. It seems clear that some turtles that remain in waters of the southeastern United States either find the bottom unsuitable for hibernation or are stunned by cold before they can take refuge in it. In a paper presented at the Florida and Interregional Conference on Sea Turtles (24–25 July 1976, Jensen Beach, Florida), Schwartz doubted the reality of fishermen's reports, heard by himself and recorded by Hildebrand & Hatsel (1926), that loggerheads hibernate. He even suggested that Felger *et al.* (1976) were hasty in accepting the Śeri Indian Folk belief. In a later publication, Schwartz (1978) gave the results of an experiment in which

loggerheads, green turtles, and ridleys, placed by him in outdoor saltwater tanks in North Carolina, grew progressively inactive as the temperature fell, and eventually passed into passivity, tail-up, helplessly buoyed by intestinal gas.

The work of Ehrhart (1977) suggests that in Mosquito Lagoon, Florida, turtles may be driven to the bottom during severe cold but for some reason fail to lodge there. During the severe winter of 1976–77, he and his students rescued 141 stunned loggerheads, green turtles, and ridleys, reviving them in a warm freshwater pond, and releasing them the following spring. Forty-three percent of these turtles had shells smeared with lagoon mud. During the winter of 1977–78 five stunned green turtles and one loggerhead were found. Whether some of the Mosquito Lagoon colony overwintered in the bottom was not determined because Ehrhart used a setnet rather than a trawl in his sampling.

The winters of 1976–77 and 1977–78 were both severe, but no seasonal temperatures of inshore waters around the Cape are available. However, Leetmaa (1977) found that fundamental changes were produced in the northwestern Sargasso Sea by the winter cooling of 1976–77. The main thermocline at the inner edge of the Gulf Stream was 100 to 150 m deeper than its average position, and there were well-mixed layers of 18 °C water as deep as 500 m.

On our second trip to the Port Canaveral Channel we saw a few turtles that must have come in from warmer water to the south. They were fat, clean, and nearly as active as turtles taken in the summer. How they came to be in the channel is not clear. Counting these apparent recent arrivals, loggerheads in four different physical states were present in the area during the winter of 1977–78, as follows: disinterred hibernators (mostly the first trip); naturally emerging hibernators (second trip); stunned, gas-buoyed derelicts (mainly in an offshore group); and a few clean-shelled, healthy turtles that clearly had just arrived in the area.

Turtles caught by the cold in coastal waters of the United States have three recourses, as follows: they can move southward to subtropical waters before the onset of torpor; they can move offshore into the Gulf Stream, which would either involve them in an Atlantic crossing, or dump them back into even colder water somewhere to the north along the US coast; or, as some at least appear to do, they can overwinter in the bottom. The prevalence of the last habit is unknown, but it ought to be determined. Sites of group hibernation in sloughs and other natural bottom depressions ought to be searched out and mapped, not only to document a little-known aspect of sea turtle ecology, but also to provide a basis for critical-habitat designations that would protect hibernating groups from disturbance by trawlers and other traffic. At the time this goes to press the National Marine Fisheries Service has initiated a year-round sampling programme in the Port Canaveral Channel. This has revealed that some aggregating occurs at all seasons. A search for sites of aggregation elsewhere in waters of the southeastern United States is also being made.

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